

REMARKS

Claim 1 has been amended. Claims 1-14 are pending in the application.

Claim Objections

In order to expedite allowance of this application, claim 1 has been amended to replace the term "substantially pure" with "purified," as suggested by the Examiner. However, Applicants point out that the invention defined in claim 1 as amended requires only that the purified ethyl acetate recovered from the distillation of the feedstock comprising ethyl acetate, ethanol and water be more pure than it is in the feedstock.

Objection to the Abstract

The abstract has been amended to remove the words "comprising" and "comprises." Reconsideration of the objection to the abstract is respectfully requested.

Rejection of Claims 1-14 under 35 U.S.C. §102(b) and/or §103(a)

Reconsideration is respectfully requested of the rejections of claims 1-8, 10, 11, 13 and 14 under 35 U.S.C. §102(b) as anticipated by EP 0151886 (EP `886), and of claims 1-14 under 35 U.S.C. §103(a) as obvious in view of EP `886. The pending claims are submitted as patentable over the cited reference.

It is difficult to effectively separate a mixture comprising ethyl acetate, ethanol and water so as to recover purified ethyl acetate therefrom due to the fact that the boiling points of ethyl acetate and ethanol are relatively close to one another and binary azeotropes and ternary azeotropes having a boiling point close to that of ethyl acetate are formed. Thus, it will be appreciated that the mixture of ethyl acetate, ethanol and water is an extremely complex one.

In accordance with the present invention, Applicants have discovered an improved process for the recovery of purified ethyl acetate from a feedstock comprising ethyl acetate, ethanol and water. The process comprises providing (1) a first distillation zone maintained under distillation conditions, including use of a first distillation pressure, that are effective for distilling of a first distillate comprising ethyl acetate, ethanol, and not more than 10 mol % water and yielding an ethanol rich bottom product comprising ethanol; and (2) a second distillation zone maintained under distillation conditions, including use of a second distillation pressure higher than the first distillation pressure, that are effective for distilling a second distillate comprising ethanol, water, and a minor proportion of ethyl acetate, and yielding a purified ethyl acetate bottom product. The feedstock comprising ethyl acetate, ethanol and water is supplied to a zone selected from the first distillation zone and the second distillation zone. A first distillate comprising ethyl acetate, ethanol, and not more than about 10 mol % water and an ethanol rich bottom product comprising ethanol and water are recovered from the first distillation zone. Material of the first distillate is supplied to the second distillation zone. A second distillate comprising ethanol, water, and a minor proportion of ethyl acetate and a purified ethyl acetate bottom product are recovered from the second distillation zone. Material of the second distillate is recycled to the first distillation zone.

EP `886 describes a process for recovering a product ester (e.g., ethyl acetate) from a reaction product mixture including an azeotrope of a unreacted primary C₂ alkanol (e.g., ethanol) and the product ester. It is said that such an azeotrope can be separated from the bulk of the product ester by distillation. In one preferred procedure of EP `886, the reaction product mixture

is distilled in a plurality of stages, including a low pressure distillation stage at a pressure of not more than about 5 bar and a subsequent high pressure distillation stage at a pressure of from about 10 bar to about 40 bar. The low pressure distillation stage results in the production of a bottom product comprising predominantly primary C₂₊ alkanol and an overhead product that is a first azeotrope of the primary C₂₊ alkanol and a major molar amount of the ester. The first azeotrope is thereafter subjected to distillation in the high pressure distillation stage to produce a bottom product comprising predominantly the ester and an overhead product that is a second azeotrope of a major molar amount of the primary C₂₊ alkanol and the ester. The second azeotrope can be recycled to the low pressure distillation stage (See page 10, line 17 to page 11, line 31). However, this disclosure does not consider the problems associated with the presence of water.

In order to anticipate under 35 U.S.C. §102(b), a prior art reference must describe, either expressly or inherently, each and every element as set forth in a claim. See MPEP § 2131. EP `886 fails to describe each and every element of claim 1 and, as such, cannot anticipate the claims of the present invention.

More particularly, EP `886 fails to describe a process for separating an ester such as ethyl acetate from a feedstock comprising ethyl acetate, ethanol and water, as required by claim 1 and certainly does not disclose a recovery scheme for such a feedstock including a plurality of distillation stages in which a first distillate comprising ethyl acetate, ethanol and not more than about 10 mol % water is recovered from a first distillation zone as called for in step (d) of claim 1. Accordingly, the process defined in claim 1 and dependent claims 2-8, 10, 11, 13 and 14 is novel over the disclosure in EP`886.

Applicants further submit that EP `886 fails to render the process of claim 1 obvious under 35 U.S.C. §103(a). In order to establish a *prima facie* case of obviousness, the Patent Office must establish, among other things, that there is some suggestion or motivation, either in the references or in the knowledge generally available to one of ordinary skill in the art, to modify the reference teachings and obtain the claimed invention. Applicants respectfully submit that the Office action does not account for the deficiencies of the primary reference and fails to establish a *prima facie* case of obviousness.

As noted above, EP `886 fails to consider and does not suggest Applicant's solution to the problem posed by the presence of water in a process for recovering purified ethyl acetate. The cited reference discloses that the overhead streams of the low pressure and high pressure distillation stages are azeotropes of the primary C₂ alkanol and a major amount of the ester (See page 11, lines 14 to 24). In accordance with EP `886, the distillate product of the low pressure distillation column has a 53.4/46.2 mol ratio ethyl acetate/ethanol azeotrope (See page 22 lines 14 to 24). Applicants draw to the Examiner's attention to the fact that the binary azeotrope of ethyl acetate and ethanol described in EP `886 at 1.03 bar (760 mmHg) is reported to have a composition of 69 wt% ethyl acetate and 31 wt% ethanol which is essentially equivalent to 53.8 mol % ethyl acetate and 46.2 mol % ethanol and has a boiling point of 71.81°C.¹ Since water forms a minimum boiling azeotrope with ethyl acetate and ethanol, it is apparent from the foregoing that water is not present in the azeotrope as taught in EP `886. Thus, there is no mention in this teaching of EP `886 of a system comprising ethyl acetate,

¹Information obtained from "Azeotropic Data - III" compiled by L. H. Horsley, published by the American Chemical Society as part 116 of the Advances in Chemistry Series (1973).

ethanol and water, much less, if such a system were present, any suggestion that the disclosed recovery procedure should be modified in accordance with claim 1 to overcome the problems attendant the presence of water and recover purified ethyl acetate.

Applicants note that in Examples 1-3 of EP `886, passing reference is made to the presence of water in the reaction product mixture. However, the cited reference does not teach that the pressure swing distillation system disclosed therein is suitable or could be modified for recovery of purified ethyl acetate from a water-containing reaction product mixture in accordance with the process of claim 1.

Nevertheless, even if it is assumed that water may be present in the reaction product mixture of EP `886 fed to the pressure swing distillation system, some means of water removal would be required, for example, if necessary to meet specifications that limit the water content of commercial ethyl acetate products (typically 0.05 wt% water). From Fig. 2 of EP `886, it is clear that any water in the reaction product mixture would need to be removed from the product ethyl acetate in column 121. The person skilled in the art would expect that this would be achieved in an analogous way to that taught at page 10, lines 17 to 24 of EP `886 for the separation of the unreacted C₂+ alkanol. A similar process would be used if the alternative arrangement of Fig. 3 of EP `886 were considered to provide a water free stream to column 140. The cited reference goes on to teach at page 10, lines 24 to 30 that the azeotrope stream can be used as fuel or recycled and that in accordance with conventional practice, purge streams can be taken in order to control the level of inerts and/or byproducts in the recycle stream. Thus, EP `886 teaches the person skilled in the art that where compounds are present that are not desired, they should be

removed such as by separation for the alkanol or by purge. There is no suggestion that water could or should be present nor that if it is present in a feedstock comprising ethyl acetate, ethanol and water, it could or should be managed in the manner defined in the process of claim 1.

It will be acknowledged that the ethyl acetate/ethanol/water system has a minimum boiling ternary azeotrope. Even if the cited reference is interpreted to mean that the overheads of the low pressure column contain water, then the teaching is that the overheads of the low pressure column is a minimum boiling point mixture of ethanol, water and a major molar amount of ethyl acetate. However, this minimum boiling mixture contains more than the requisite 10 mol % water called for in step (d) of claim 1 over the whole range of pressures for the low pressure column taught in EP '886. Limiting the water content of the lower pressure distillation zone overhead or distillate to no more than about 10 mol % is an essential feature of the claimed invention.

For example, the ternary azeotrope composition at 1.03 bar (760 mm Hg) is reported to be 9 wt% water, 8.26 wt% ethyl acetate and 8.4 wt% ethanol (equivalent to 30.8 mol % water, 57.9 mol % ethyl acetate, and 11.3 mol % ethanol). This ternary azeotrope has a boiling point of 70.23°C. As described above, the binary azeotrope of ethyl acetate and ethanol at the same pressure is reported to have a composition of 69 wt% ethyl acetate and 31 wt% ethanol (equivalent to 53.8 mol % ethyl acetate and 46.2 mol % ethanol) and a boiling point of 71.81°C.² Based on this data, it can be calculated that a liquid mixture containing 10 mol % water, a major molar amount of ester (45.1 mol % ethyl acetate) and the balance of ethanol (44.9 mol %) will have a boiling point of 71.3°C. This boiling point is higher than the ternary

² Id.

azeotrope boiling point of 70.23°C noted above and does not constitute a minimum boiling point as required by the recognized definition of an azeotrope (i.e., a liquid mixture that is characterized by a constant minimum or maximum boiling point which is lower or higher than that of any of the components and that distills without change in composition). Furthermore, the vapor distilling from a liquid of this composition would be expected to be composed of 10.5 mol % water, 48.7 mol % ethyl acetate and 40.8 mol % ethanol. This is a significant change in composition and therefore does not meet the further requirement of the azeotrope definition that the mixture distills without change in composition. Thus, it is further evident that EP `886 does not teach nor suggest the complex mixture comprising ethyl acetate, ethanol, and water and its treatment in accordance with the process of claim 1 to recover purified ethyl acetate.

It is also apparent from the range of pressure taught as suitable for the low pressure column in EP `886 that in the event there was any water present that such water content of the column overheads should be limited to less than that of the azeotropic composition. It is noted that EP `886 teaches that the pressure of the low pressure column should be limited to about 5 bar. At this pressure the composition of the ternary azeotrope contains less ethyl acetate than at 1 bar. The ternary azeotrope composition is estimated to be about 39 mol% ethyl acetate, 36 mol% ethanol and 25 mol% water. It will also be understood that the ethyl acetate concentration in the overheads is limited to a maximum of that present in the ternary azeotrope composition. Consequently, if it were desired to operate with an overhead composition containing less water then it is necessary that the ethanol content be increased. Step (d) of Claim 1 requires that the first distillate comprises not more than 10 mol% water. Clearly it would not be possible to reduce the water content to

less than 10 mol% and to maintain a major molar amount of ethyl acetate as is required by the teaching of EP `886. This is
* illustrated in the enclosed Diagram 2. Thus, it is believed that
EP `886 teaches that the low pressure column should be operated
such that the compositions therein should contain not less than
20% water.

In view of the above, claim 1 is submitted as patentable over EP `886. Claims 2-14, which depend from claim 1, are likewise submitted as patentable for the reasons set forth above.

Information Disclosure Statement

* Enclosed herewith is a Supplemental Information Disclosure Statement. Applicants respectfully request review and entry of the cited references.

Cite No. 18, U.S. Patent No. 6,809,217 is assigned to the assignee of the subject patent application, Davy Process Technology Limited. Similarly, U.S. Patent No. 6,632,330 made of record by the Examiner is also commonly assigned. Applicants wish to bring these two references to the Examiner's particular attention for consideration of any potential double patenting issues.

Conclusion

In view of the above, favorable reconsideration and allowance of all pending claims are respectfully solicited.

The Commissioner is requested to charge any fee deficiency in connection with this amendment to Deposit Account No. 19-1345.

Respectfully submitted,



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